DEPARTMENT OF COMMERCE AND LABOR

TECHNOLOGIC PAPERS

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 9

DENSITY AND THERMAL EXPANSION OF LINSEED OIL AND TURPENTINE

(INCLUDING CONVERSION TABLES OF POUNDS TO GALLONS AND GALLONS TO POUNDS)

BY

H. W. BEARCE, Assistant Physicist
Bureau of Standards

[APRIL 15, 1912]

WASHINGTON
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By H. W. Bearce

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TABLES

INTRODUCTION

An investigation of the density and thermal expansion of linseed oil and turpentine was undertaken in response to a demand from those engaged in the manufacture, distribution, and use

of these substances, for more complete knowledge of their physical constants as an aid in setting up standards of purity. There appears also to be a considerable demand for tables showing the change of density of these materials with change of temperature, and for conversion tables for changing from pounds to gallons and from gallons to pounds. The need for such conversion tables arises from the fact that both linseed oil and turpentine are often bought by weight and sold by measure and vice versa. Tables based upon the results of this investigation have been prepared and are published at the end of this paper.

MATERIAL USED

The samples of linseed oils used in this investigation were secured from the American Society for Testing Materials, through the courtesy of Mr. S. S. Voorhees, a member of the special committee appointed by that society to carry out an investigation of commercial linseed oils. The origin and history of the samples used was as follows:

Samples Nos. 1 to 4, inclusive, were from the same lots of oil as that reported on at the 1909 meeting of the American Society for Testing Materials. In addition to the bottles filled at the time the samples were taken (February, 1909), two 5-gallon cans of each sample were filled and sealed for future examination, to determine the effect of aging. The cans were nearly full and were hermetically sealed. One of these cans for each sample was opened February 23, 1911, and the oil thoroughly mixed and bottled.

Sample No. 5 was obtained from a 5-gallon can taken on June 15, 1910, at the American Linseed Co.'s South Chicago mill. Can opened and bottled March 1, 1911; oil made from North American seed.

Sample No. 6 was obtained July 21, 1910, at Archer-Daniels Linseed Co.'s Minneapolis mill. Oil bottled March 1, 1911; oil made from North American seed.

Samples Nos. 7 to 16, inclusive, were taken with the idea of observing the variation in the constants of pure raw linseed oil, as affected by the origin and age of the seed from which they were made. The samples were received in sealed cans by the com-

mittee and were opened and bottled February 18, 1911. All samples except No. 16 were from North American seed.

Sample No. 7 was taken at Archer-Daniels Linseed Co.'s Minneapolis mill about September 30, 1910.

Sample No. 8 was taken at Archer-Daniels Linseed Co.'s Minneapolis mill October 27, 1910.

Sample No. 9 was taken at Archer-Daniels Linseed Co.'s Minneapolis mill about November 30, 1910.

Sample No. 10 was taken at Archer-Daniels Linseed Co.'s mill about December 31, 1910.

Sample No. 11 was taken at Hirst & Begley's Chicago mill, September 30, 1910, largely from Southwestern seed.

Sample No. 12 was taken at Hirst & Begley's Chicago mill October 31, 1910, from Northwestern seed.

Sample No. 13 was taken at Hirst & Begley's Chicago mill November 29, 1910, from Southwestern seed.

Sample No. 14 was taken at Hirst & Begley's Chicago mill December 29, 1910, from Northwestern seed.

Sample No. 15 was taken at Hirst & Begley's Chicago mill January 31, 1911, from Northwestern seed.

Sample No. 16 was taken at the National Lead Co.'s Atlantic mill February 24, 1911, from Argentine seed.

The samples of turpentine used in this investigation, while fewer in number than the samples of linseed oil, may, it is believed, be considered fairly representative of the articles of commerce known as "spirits of turpentine," "turpentine," and, in the paint trade, as "turps." The origin of the various samples, as far as known, is as follows:

Sample No. 1 was purchased under Government contract as "turpentine."

Samples Nos. 2 and 3 were purchased in the retail trade of Washington, D. C., as "turpentine."

Samples Nos. 7 and 8 were furnished by the Geo. L. Morton Co., of Wilmington, N. C.—No. 7 as pure gum spirits from first year's run (virgin dip) and No. 8 as pure gum spirits from later run (yellow dip).

Sample No. 12 was furnished by the Hendrics Turpentine Co., of Tampa, Fla., as pure gum spirits distilled from second year's run without use of steam.

In addition to the above samples of gum turpentine, several samples of wood turpentine and other products of the distillation of wood were secured and tested. The samples were as follows:

Sample No. 4, furnished by the Waycross Power & Light Co., Waycross, Ga., was obtained by the distillation of waste wood by the steam process.

Samples Nos. 9, 10, and 11, furnished by F. T. Sutherland & Co., of Jacksonville, Fla., were obtained from the distillation of waste wood by the steam process. No. 11 was a part of the last fraction of the distillation in which No. 10 was secured. No. 11 is known as "oil" of turpentine.

Samples Nos. 5 and 6, furnished by the Spiritine Chemical Co., of Wilmington, N. C., were obtained by destructive distillation of waste wood.

All of the above samples, except Nos. 1, 2, and 3, were secured direct from the producers, most of them being delivered at the place of production to Mr. M. H. Stillman of this Bureau.

The 16 samples of linseed oil reported on in this paper, being taken as they were at various times under ordinary working conditions at several of the more important mills of this country, are, it is believed, thoroughly representative of the oil obtained from North American seed. The one sample examined from imported seed was not found to differ essentially from those obtained from North American seed. It is hoped that at some future time the work may be extended to embrace oil made from seed imported from all other important seed-producing countries.

The number of samples of turpentine reported on in this paper is undoubtedly too small to base general conclusions upon, but at the same time it is sufficient to indicate some of the more important facts. It is hoped that the work on turpentine also may be continued with a greater number of samples of known origin and purity.

DESCRIPTION OF EXPERIMENTAL WORK

METHOD OF DETERMINATION OF DENSITY

After obtaining the various samples of linseed oil and turpentine the density of each sample was determined at 10°, 20°, 30°, and 40° C by the method of hydrostatic weighing; that is, by weighing in the sample a sinker of known mass and volume.

The apparatus used in making the density determinations was devised by Mr. N. S. Osborne, formerly of this bureau, and used by him in his work on the density and thermal expansion of ethyl alcohol. A complete description of the apparatus may be found in the publication of that work.

DESCRIPTION OF APPARATUS

The arrangement of apparatus is as follows:

The sample under investigation, and the sinker, are placed in a tube having a length of about 50 cm and a diameter of 2 cm, and surrounded by a temperature bath kept in constant circulation by a small propeller. This inner bath is surrounded by a second bath, which is also kept in constant circulation and whose temperature can be maintained constant or varied at will over a range of 10° to 40° C, the temperature regulation being accomplished by an electric heating coil and a copper coil through which refrigerating brine may be passed. These coils, together with a thermostat, may be so adjusted that any desired temperature between 10° and 40° C is automatically maintained.

The outside containing vessel for the various tubes and baths is a large, unsilvered Dewar cylinder, provided with a brass cap suitable for supporting the inner parts of the apparatus. The cylinder is mounted in a vertical position and covered with a layer of nickeled paper through which windows are cut to permit observations to be made.

The temperature is read on two mercurial thermometers suspended in water in a tube placed symmetrically with that containing the sample whose density is to be measured. The thermometers are so mounted on a movable cap that by its rotation they may be successively brought into position for reading. They are

36248°—12——2

read by the aid of a long-focus microscope so mounted as to be movable vertically. The object of placing the thermometers in a tube instead of directly in contact with the water of the inner circulating bath is to eliminate, as far as possible, errors due to temperature lag within the densimeter tube. Since the sample under test is separated from the circulating bath by the densimeter tube the thermometers should be separated from it by a similar tube in order that when a constant temperature is indicated by them the same constant temperature shall obtain within the densimeter tube.

The thermometers were used repeatedly over the same temperature range, and from previous experience with the same thermometers over the same range it was thought unnecessary to take ice-point readings after each reading of the thermometers. Ice-point readings were, however, taken occasionally throughout the work and these, together with an extended series obtained earlier in the year, were found to be sufficiently concordant to warrant their use in fixing the corrections to be applied at the various temperatures.

THERMOMETERS

The thermometers used were: B. S. No. 4653, made by Tonnelot in 1888 of Verre dur glass; B. S. No. 2040, by Haak in 1906, of Jena 16^{III} glass; B. S. No. 264, by Richter in 1902, of Jena 16^{III} glass. All thermometers were graduated to 0°1 C.

SINKER

The sinker used was of Jena 16^{III} glass, ballasted with mercury; its volume, used in making the density determinations was calculated from its weight in vacuo and its apparent weight in twice distilled water at 4°, 10°, 20°, 30°, and 40° C, using Chappuis's values for the density of water. The equation

$$V_t = V_x + \alpha(t-x) + \beta(t-x)^2$$

was assumed to represent sufficiently well the expansion of the sinker, and the values of V_x, α, and β, obtained by making a least squares reduction of the observations, were:

$$V_x = V_{24} = 47.7174 \text{ cc}$$

$$\alpha = 0.001\ 100\ 1$$

$$\beta = 0.000\ 000\ 973\ 4$$

Therefore $V_t = 47.7174 + 0.001\ 100\ 1(t-24) + 0.000\ 000\ 973\ 4\ (t-24)^2$ from which the calculated volumes are as follows:

Temperature	Volume
10° C	47.7022 cc
20° C	47.7130 cc
30° C	47.7240 cc
40° C	47.7352 cc

The sinker is suspended by a hook from a small secondary sinker attached to a wire let down from one pan of the balance. The secondary sinker has a mass sufficient to keep the suspension wire straight and in its proper position, and is always immersed in the liquid, whether the large sinker (of known mass and volume) is attached or not.

At the point where the suspension wire passes through the surface of the liquid it has a diameter of 0.3 mm and is covered with a layer of unpolished gold by electro deposition. In the case of liquids which imperfectly wet the suspension, this roughening of the surface is essential, but with oil and turpentine it was probably unnecessary.

BALANCE, WEIGHTS, AND METHOD OF WEIGHING

All weighings were made by the method of substitution; that is, a constant mass was kept on one pan of the balance and the weighings made on the other, sufficient weights being placed on the pan to secure equilibrium, first with the sinker attached and then detached. The weighings were made on a Rueprecht analytical balance (B. S. No. 5156) having the capacity of 200 grams and a sensibility of 0.08 mg per division when undamped. When the immersed sinker was attached the sensibility was greatly reduced, especially in the case of linseed oil at the lower temperatures, owing to the increased viscosity of the oil. At the higher temperatures weighings could be made to a few tenths of a milligram, but at 10° difficulty was experienced in weighing closer than from 1 to 2 mg.

Of the weights used, those of less than 1 g were a special set provided with the balance, and were manipulated by keys on the outside of the balance without opening the case. Those between 1 g and 100 g were platinum plated brass weights (B. S. No. 5157).

These weights are used only for special purposes and were recalibrated a few months before the beginning of this work, and the maximum error of any possible combination of weights was found to be so small in comparison with accidental errors as to be negligible.

All weighings were reduced to vacuo by means of a special device originally designed for use in correcting weighings of water in the test of volumetric apparatus. This apparatus consists of a glass bulb of such a volume that, when suspended from one arm of a balance and counterpoised against a brass weight of equal mass, the number of milligrams that must be added to the pan from which the bulb is suspended to secure equilibrium is equal to the air buoyancy on a liter of water weighed against brass weights. This buoyancy constant when divided by 881.3 gives the air density. (881.3 is the difference in volume between the brass weights and the glass bulb).

METHOD OF PROCEDURE

In making the density determinations the method of procedure was as follows:

The water in the outside circulating bath was brought to the desired temperature and, before observations were begun, sufficient time was allowed to elapse for the apparatus to reach the steady state. When the thermometers in the inner tube indicated a constant temperature it was assumed that the liquid in the densimeter tube was at the same constant temperature and observations were begun. First, a weighing was made with the sinker suspended in the sample, then the temperature was observed on each of two thermometers; next, a weighing was made with the sinker off, then a second with the sinker on, and after that a second observation of temperature. The temperature was then changed to the next point of the series and here the same order was followed.

CALCULATION OF RESULTS

After completing the observations at the four temperatures 10°, 20°, 30,° and 40° C, the density at each temperature was calculated by means of the equation

$$D_t = \frac{W - \frac{(w - w_1) + (w - w_2)}{2}\left(1 - \frac{\rho}{8.4}\right)}{V_t}$$

in which D_t = density[1] of sample at the temperature t

W = weight of sinker in vacuo
w = weighing with sinker off
w_1 & w_2 = weighings with sinker on
ρ = air density
8.4 = assumed density of brass weights
V_t = volume of sinker at temperature t.

After calculating the density of a sample at 10°, 20°, 30°, and 40° C, it was assumed that the rate of expansion could be represented by the equation

$$D_t = D_x + \alpha(t - x) + \beta(t - x)^2$$

and a least squares reduction was applied to the observed densities in order to find D_x, α, and β, and the most probable value of the density at each temperature.

The observations and reductions of an average sample of linseed oil are given on pages 16 and 17, and following that a summary of the 16 samples of linseed oil arranged in the increasing order of their densities.

DISCUSSION OF RESULTS

It will be seen from the tabulated results that the coefficient of expansion of linseed oil, as determined from the 16 samples tested, varies over rather narrow limits; for example, at 25° C the change of density per degree lies between 0.000 682 and 0.000 687, the mean of the 16 samples being 0.000 684 7. It will be seen also that the rate of change of density is, in general, greater at the lower than at the higher temperatures. Sample No. 9, the only exception, contained a very large amount of suspended matter which was no doubt responsible for the difference observed. It further appears from the tabulated results that the coefficient of expansion

[1] Throughout this paper the term "density" is used to denote the mass of the liquid per unit volume, expressed in grams per milliliter. The densities are, therefore, numerically equal to specific gravities referred to water at 4° C as unity.

is slightly greater for the heavier than for the lighter oils, the mean of the first half of the series being 0.000 684 2 per degree at 25° and of the last half 0.000 685 2. This fact should not, however, be given great weight, as three samples in the first half fall above and four samples in the last half fall below the mean value.

Following the summary of the results of the linseed oil investigation is given a similar summary of those on gum turpentine, wood turpentine, and "wood spirits." From this table it will be seen that the limits of the density and coefficient of expansion of turpentine, while not so narrow as for linseed oil, still are not wide. The change of density of gum turpentine per degree at 25° C lies between 0.000 810 and 0.000 820, with a mean value of 0.000 817 0. Here again, and more noticeably than in the case of linseed oil, the rate of change of density with change of temperature is greater for the heavier than for the lighter samples, but unlike the oil, the rate of change is in this case greater at the higher than at the lower temperatures.

This investigation has shown that if the density of a sample of linseed oil or turpentine be determined at 25°, its density at any other temperature between 10° and 40° C may be calculated within the limits of ordinary experimental error by use of the general equation

$$D_t = D_{25} + \alpha(t-25) + \beta\,(t-25)^2$$

which, on the substitution of the mean values of α and β, becomes for linseed oil

$$D_t = D_{25} - 0.000\,684\,7\,(t-25) + 0.000\,000\,12\,(t-25)^2$$

and for gum turpentine

$$D_t = D_{25} - 0.000\,817\,0\,(t-25) - 0.000\,000\,09\,(t-25)^2$$

Or the density may be measured at any other convenient temperature and for short temperature intervals the correction factor applied as a single term.

In the tables given at the end of this paper the values for turpentine have been extended somewhat beyond the range of the densities actually measured in this investigation in order to more nearly cover the range found by Veitch and Donk [2] in their recent investigation of a great number of commercial turpentines.

[2] Bureau of Chemistry, Bull. No. 135, Apr., 1911.

In calculating the turpentine tables the mean value of the rate of change of density with change of temperature has not been used. The greater rate of change of the heavier turpentines has been taken into account by applying to the mean value a correction deduced from the difference between the mean rate of change of the three heaviest and the three lightest samples.

In regard to the accuracy of the results given in this paper, it is believed that in all cases except that of linseed oil at 10° C the density determinations are correct to within three units of the fifth decimal place, and in this case to five units of the fifth place. This corresponds to an accuracy of about 1 part in 30 000, and 1 part in 18 000, respectively. The decreased accuracy is due to the increased viscosity of the oil and the resulting decreased sensibility of the balance.

COMPARISON OF RESULTS WITH PREVIOUS WORK

A comparison of the results of the present investigation with other published results may be of interest. The scarcity of data available and the doubt as to the actual meaning of the term "specific gravity," as ordinarily employed, render such a comparison in many cases impossible. The values given by Allen [3] and by Andès [4] for the coefficient of expansion of linseed oil are, respectively, 0.000 649 and 0.000 63 per degree C. Ennis [5] gives 0.000 45 per degree F. (0.000 81 per degree C). The low value given by Allen may be explained, at least in part, by his assumption that the coefficient of expansion is the same at all temperatures. He measured the density at two widely separated temperatures, and thus obtained the mean rate of change of density between these temperatures. Since the present work has shown that the rate of change is less at the higher than at the lower temperatures, Allen's mean coefficient is too low for ordinary laboratory temperatures. Hurst [6] gives a value of 0.000 65, and Maire [7]

[3] Commercial organic analysis, vol. 1, pt. 1.
[4] Boiled oils, drying oils, etc.
[5] Linseed oil and other seed oils.
[6] Painters' colors, oils, and varnishes.
[7] Modern pigments and their vehicles.

0.000 63, but Maire's application of the coefficient as a temperature correction to the density is in the wrong direction. The most complete and definite results found are those given by Sabin.[8] He gives as the coefficient of expansion of linseed oil between 15.5° and 28° C, 0.000 692; and between 28° and 100° C 0.000 720 per degree. This value of the coefficient between 15.5° and 28° C is in better agreement with the results of the present work than any other found, but the increased coefficient at the higher temperatures, reported by Sabin, is not confirmed by this work.

PHYSICAL AND CHEMICAL CONSTANTS OF THE LINSEED OIL SAMPLES EXAMINED

The results given below are the mean values of the independent determinations by seven chemists to whom the samples were submitted by subcommittee E of the American Society for Testing Materials. A detailed report of this committee is published in the 1911 proceedings of that society.

Sample No.	Refractive index at 25° C	Iodine No. (Hanus)	Acid No.	Saponification No.	Unsaponifiable matter	Density at 25° C grams/ml.[9]
1	1.4799	186.9	1.39	190.7	0.96	0.927 56
2	1.4792	183.0	4.38	190.8	0.96	0.925 68
3	1.4793	186.0	2.79	190.2	0.98	0.925 86
4	1.4794	184.1	1.86	190.4	1.04	0.927 06
5	1.4785	179.0	4.54	190.9	0.97	0.924 80
6	1.4782	177.9	2.04	190.6	1.06	0.926 38
7	1.4790	181.4	2.12	191.3	1.08	0.926 88
8	1.4793	183.0	1.49	190.9	1.10	0.926 80
9	1.4793	182.2	1.83	191.2	1.15	0.927 20
10	1.4795	184.2	1.59	191.7	1.06	0.927 30
11	1.4789	179.4	0.97	190.9	1.10	0.925 78
12	1.4792	183.4	0.98	190.4	1.04	0.925 96
13	1.4790	180.7	0.94	191.2	1.12	0.925 34
14	1.4796	187.0	0.99	190.8	1.01	0.926 72
15	1.4796	184.9	1.70	191.3	1.03	0.927 20
16	1.4779	172.4	1.24	190.6	1.05	0.924 99

[8] Technology of paint and varnish.

[9] Determinations by author.

PHYSICAL AND CHEMICAL CONSTANTS OF THE GUM TURPENTINE SAMPLES EXAMINED

Below are given the physical and chemical constants of the six samples of turpentine on which Table IV is based.

Sample No.	Initial distilling temperature, °C	Per cent distilling below—			Per cent polymerization residue	Per cent residue on drying at 105° C	Refractive index at 27° C	Optical rotation at 25° C [10]	Per cent mineral oil	Density at 25° C grams/ml.[11]
		160° C	165° C	170° C						
1	156	29	47	64	1.6	21.24	1.4784	+14.4	Less than 5	0.862 40
2	157	28	51	72	1.6	10.12	1.4710	− 7.2	do	0.859 84
3	157	20	83	91	3.2	1.17	1.4671	− 8.6	do	0.857 19
7	156	49	87	94	0.8	1.87	1.4673	+15.9	do	0.857 66
8	155	39	85	93	1.6	1.60	1.4670	+12.7	do	0.860 32
12	154	41	89	94	2.4	1.03	1.4672	+ 4.3	do	0.861 66

[10] The optical rotation is calculated by use of the equation

$$\text{Optical rotation} = \frac{\text{angle of rotation}}{\text{length of solution, in cms.} \times \text{density at } 25^\circ \text{ C}}$$

[11] Determinations by author.

In connection with this table it should be stated that, owing to the limited quantities of the several samples, the chemical constants given are, in each case, the results of a single determination only and do not therefore represent the same degree of accuracy as do the corresponding values for linseed oil. No attempt will be made to explain the abnormally high residues on drying at 105° C, and the relatively low percentages distilling below 170° C, of samples Nos. 1 and 2, as the samples were too small for further investigation.

In conclusion, the author would acknowledge his indebtedness to the chemical division of this Bureau for the analysis of the turpentine samples; to Messrs. Nutting and Jackson, also of this Bureau, for determining the refractive index and optical rotation, respectively; and to the American Society for Testing Materials for the samples of linseed oil and for the chemical analysis made by members of that society.

WASHINGTON, D. C., November 1, 1911.

SAMPLE SET OF OBSERVATIONS

Linseed Oil. Sample No. 6. Observations and Calculation of Densities

Date	Temperatures		Corrected temperatures	Balance reading	Apparent weight	Air buoyancy	Corrected weight	Weight of sinker (in vacuo)	Weight of displaced liquid	Volume	D_t	D_t (reduced to integral degrees)
April 13, 1911	#2040	#4653										
12.30 p. m.	−.008 10.055 10.028	+.091 9.975 9.972	10.047 10.066 10.020 10.063	38.5045 93.8308 38.5045	55.3263 55.3263	1052 22°.8 25°.2 1042 .001182						
			10.049		55.3263	−.0078	55.3185	99.9990	44.6805	47.702 18	0.936 655 +34	0.936 689 (10° C)
1.40 p. m.	−.003 19.870 19.875	+.036 19.828 19.848	19.867 19.864 19.872 19.884	38.1802 93.8191 38.1790	55.6389 55.6401							
			19.872		55.6395	−.0078	55.6317	99.9990	44.3673	47.712 82	.929 882 −88	.929 794 (20° C)
2.40 p. m.	−.005 29.960 29.965	+.005 29.960 29.962	29.955 29.965 29.960 29.967	37.8496 93.8072 37.8486	55.9576 55.9586							
			29.962		55.9581	−.0078	55.9503	99.9990	44.0487	47.723 94	.922 990 −26	.922 964 (30° C)
3.25 p. m.	#264 −.033 39.780 39.795		39.747 ...... 39.762	37.5280 93.7962 37.5274	56.2682 56.2688							
			39.754		56.2685	−.0079	56.2606	99.9990	43.7384	47.734 92	.916 277 −168	.916 109 (40° C)

NOTE.—In the above column headed "Air buoyancy" 1052 is the observed buoyancy constant, 22°.8 C is the temperature at the buoyancy bulb, 25°.2 C is the temperature in the balance, 1042 is the buoyancy constant corrected to the temperature of the balance, 0.001 182 is the air density in the balance, 0.0078 g is the buoyancy correction to be applied to the apparent weight.

SAMPLE OF REDUCTION OF OBSERVATIONS

Linseed Oil. Sample No. 6

t	$\frac{(t-t_m)}{C_1}$	C_1^2	$\frac{[C_1^2-(C_1^2)_m]}{C_2}$	C_2^2	D_t	$\frac{[D_t-(D_t)_m]}{N}$	C_1N	C_2N
10	−15	225	100	10 000	0.936 689	+0.010 300	−0.154 50	+1.0300
20	− 5	25	−100	10 000	.929 794	+ .003 405	− .017 02	− .3405
30	5	25	−100	10 000	.922 964	− .003 425	− .017 12	+ .3425
40	15	225	100	10 000	.916 109	− .010 280	− .154 20	−1.0280
25		500		40 000	.926 389		− .342 84	+ .0040

$$500\alpha = -0.342\ 84$$
$$\alpha = -.000\ 685\ 7$$
$$40\ 000\beta = +.004$$
$$\beta = +.000\ 000\ 1$$

$$D_x + 125\beta = D_m$$
$$D_x = D_{25} = 0.926\ 389 - 0.000\ 012$$
$$D_{25} = 0.926\ 377$$
$$D_t = D_{25} + \alpha(t-25) + \beta(t-25)^2$$
$$D_t = 0.926\ 377 - 0.000\ 685\ 7(t-25) + 0.000\ 000\ 1(t-25)^2$$

t	t−25	$(t-25)^2$	$\alpha(t-25)$	$\beta(t-25)^2$	Calculated D_t	Observed D_t	Obs.—cal.
10	−15	225	+0.010 286	+0.000 022	0.936 68	0.936 69	1
20	− 5	25	+ .003 428	+ .000 002	.929 81	.929 79	−2
30	5	25	− .003 428	+ .000 002	.922 95	.922 96	1
40	15	225	− .010 286	+ .000 022	.916 11	.916 11	0

SUMMARIES OF RESULTS

Density and Thermal Expansion of Linseed Oil at Temperatures Between 10° and 40° C

Sample No.	$D\frac{10°}{4°}C$	$D\frac{20°}{4°}C$	$D\frac{30°}{4°}C$	$D\frac{40°}{4°}C$	$D\frac{25°}{4°}C$	$\alpha\times10^7$	$\beta\times10^9$
5	0.935 13	0.928 23	0.921 39	0.914 60	0.924 80	−6844	+262
16	.935 26	.928 41	.921 58	.914 75	.924 99	−6836	+ 50
13	.935 61	.928 75	.921 93	.915 14	.925 34	−6823	+192
2	.935 98	.929 11	.922 26	.915 43	.925 68	−6851	+ 90
11	.936 06	.929 20	.922 35	.915 52	.925 78	−6848	+ 58
3	.936 14	.929 28	.922 44	.915 61	.925 86	−6843	+ 90
12	.936 24	.929 38	.922 55	.915 73	.925 96	−6838	+ 95
6	.936 68	.929 81	.922 95	.916 11	.926 38	−6857	+100
14	.937 04	.930 16	.923 29	.916 42	.926 72	−6875	+ 38
8	.937 10	.930 22	.923 38	.916 57	.926 80	−6843	+168
7	.937 16	.930 31	.923 47	.916 64	.926 88	−6840	+ 78
4	.937 38	.930 49	.923 65	.916 86	.927 06	−6842	+240
9	.937 46	.930 62	.923 77	.916 91	.927 20	−6850	− 88
15	.937 55	.930 63	.923 78	.916 99	.927 20	−6852	+320
10	.937 61	.930 73	.923 89	.917 07	.927 30	−6844	+155
1	.937 89	.931 00	.924 13	.917 27	.927 56	−6873	+ 78
Mean					.926 34	−6847	+120

(1) $$D_t=D_{25}+\alpha(t-25)+\beta(t-25)^2$$

Taking for α and β the mean values of the 16 samples the general equation becomes $D_t=D_{25}-0.000\ 6847(t-25)+0.000\ 000\ 12(t-25)^2$. If it is desired to reduce the expansion to a single term for use over a short temperature range, this may be done by differentiating the general equation and combining α and β into a single term, α^1, which will be different for different temperatures.

$$D_t=D_{25}+\alpha(t-25)+\beta(t-25)^2$$

(2) $$\frac{dD_t}{dt}=\alpha+2\beta(t-25)=\alpha^1$$

Substituting for t the values 10, 15, 20, 25, 30, 35, and 40, gives for the rate of change of density at the different temperatures the following values:

Temperature °C	Change per °C
10	0.000 688 3
15	.000 687 1
20	.000 685 9
25	.000 684 7
30	.000 683 5
35	.000 682 3
40	.000 681 1

Density and Thermal Expansion of Turpentine at Temperatures Between 10° and 40° C

Sample No.	$D\frac{10°}{4°}C$	$D\frac{20°}{4°}C$	$D\frac{30°}{4°}C$	$D\frac{40°}{4°}C$	$D\frac{25°}{4°}C$	$\alpha\times10^7$	$\beta\times10^9$	Refractive index at 27 °C	Optical rotation at 25 C°	Remarks
									°	
3	0.869 32	0.861 24	0.853 14	0.845 00	0.857 19	−8104	−150	1.4671	− 8.6	Group I, gum turpentines.
7	.869 88	.861 74	.853 57	.845 39	.857 66	−8165	− 95	1.4673	+15.9	
2	.872 11	.863 94	.855 74	.847 52	.859 84	−8195	−105	1.4710	− 7.2	
8	.872 56	.864 40	.856 23	.848 04	.860 32	−8174	− 55	1.4670	+12.7	
12	.873 93	.865 76	.857 56	.849 33	.861 66	−8198	−148	1.4672	+ 4.3	
1	.874 68	.866 49	.858 31	.850 12	.862 40	−8186	− 8	1.4784	+14.4	
Mean						−8170	− 94			
9	.869 88	.861 65	.853 41	.845 16	.857 53	−8242	− 55	1.4636	+22.9	Group II, wood turpentine steam distilled.
10	.870 24	.862 05	.853 84	.845 59	.857 95	−8214	−160	1.4656	+17.7	
4	.872 29	.864 06	.855 71	.847 24	.859 90	−8350	−580	1.4648	+26.3	
Mean						−8269	−265			
5	.873 80	.864 56	.855 47	.846 26	.860 06	−9181	−130	1.4594	+ 4.7	Group III, wood "spirits" destructively distilled.
6	.876 06	.866 93	.857 75	.848 52	.862 35	−9181	−258	1.4613	+ 4.7	
11	.955 18	.947 28	.939 30	.931 23	.943 30	−7986	−428	1.4789	0.0	"Oil" of turpentine.

The results obtained from the six samples of gum turpentine shown in Group I were used in the calculation of Table IV for determining the density of turpentine at various temperatures.

If the general equation $D_t=D_{25}+\alpha(t-25)+\beta(t-25)^2$ be differentiated and the mean values of α and β substituted in the first derivative the change of density per degree at different temperatures is seen to be as shown below.

$$D_t = D_{25} + \alpha\,(t-25) + \beta\,(t-25)^2$$

$$\frac{d\,D_t}{dt} = \alpha + 2\,\beta\,(t-25) = \text{change of density per degree} = \alpha^1$$

t	α^1
10	.000 814 2
15	815 1
20	816 1
25	817 0
30	817 9
35	818 9
40	819 8

In calculating Table IV these values of α^1 were taken as the rate of change of density of turpentine having a density of 0.8640 at 20° C (this being the mean of the six samples from which α^1 was derived). For turpentine having a density at 20° either greater or less than 0.8640 α^1 was calculated from mean D $\frac{20^\circ}{4^\circ}$ and mean α^1 of the three lightest samples, and mean $\frac{D20^\circ}{4^\circ}$ and mean α^1 of the three heaviest samples.

TABLES OF DENSITY, WEIGHT, AND VOLUME

TABLE I

Density of Linseed Oil at Temperatures from 10° to 40° C from its Density at 20° C

Required temperature	Density at 20° C (in grams per milliliter)						
	0.9260	0.9270	0.9280	0.9290	0.9300	0.9310	0.9320
	Density at required temperature						
°C							
10	0.9329	0.9339	0.9349	0.9359	0.9369	0.9379	0.9389
11	.9322	.9332	.9342	.9352	.9362	.9372	.9382
12	.9315	.9325	.9335	.9345	.9355	.9365	.9375
13	.9308	.9318	.9328	.9338	.9348	.9358	.9368
14	.9301	.9311	.9321	.9331	.9341	.9351	.9361
15	.9294	.9304	.9314	.9324	.9334	.9344	.9354
16	.9288	.9298	.9308	.9318	.9328	.9338	.9348
17	.9281	.9291	.9301	.9311	.9321	.9331	.9341
18	.9274	.9284	.9294	.9304	.9314	.9324	.9334
19	.9267	.9277	.9287	.9297	.9307	.9317	.9327
20	.9260	.9270	.9280	.9290	.9300	.9310	.9320
21	.9253	.9263	.9273	.9283	.9293	.9303	.9313
22	.9246	.9256	.9266	.9276	.9286	.9296	.9306
23	.9239	.9249	.9259	.9269	.9279	.9289	.9299
24	.9233	.9243	.9253	.9263	.9273	.9283	.9293
25	.9226	.9236	.9246	.9256	.9266	.9276	.9286
26	.9219	.9229	.9239	.9249	.9259	.9269	.9279
27	.9212	.9222	.9232	.9242	.9252	.9262	.9272
28	.9205	.9215	.9225	.9235	.9245	.9255	.9265
29	.9198	.9208	.9218	.9228	.9238	.9248	.9258
30	.9192	.9202	.9212	.9222	.9232	.9242	.9252
31	.9185	.9195	.9205	.9215	.9225	.9235	.9245
32	.9178	.9188	.9198	.9208	.9218	.9228	.9238
33	.9171	.9181	.9191	.9201	.9211	.9221	.9231
34	.9164	.9174	.9184	.9194	.9204	.9214	.9224
35	.9157	.9167	.9177	.9187	.9197	.9207	.9217
36	.9150	.9160	.9170	.9180	.9190	.9200	.9210
37	.9144	.9154	.9164	.9174	.9184	.9194	.9204
38	.9137	.9147	.9157	.9167	.9177	.9187	.9197
39	.9130	.9140	.9150	.9160	.9170	.9180	.9190
40	.9123	.9133	.9143	.9153	.9163	.9173	.9183

TABLE II

Weights (in Pounds) of Various Volumes (in Gallons) of Linseed Oil

Gallons	Density of Oil (in grams per milliliter)																
	0.9190	0.9200	0.9210	0.9220	0.9230	0.9240	0.9250	0.9260	0.9270	0.9280	0.9290	0.9300	0.9310	0.9320	0.9330	0.9340	0.9350
	Weight of Oil (in pounds)																
1	7.66	7.67	7.68	7.69	7.69	7.70	7.71	7.72	7.73	7.74	7.74	7.75	7.76	7.77	7.78	7.79	7.79
2	15.32	15.34	15.36	15.37	15.39	15.40	15.42	15.44	15.46	15.47	15.49	15.50	15.52	15.54	15.56	15.57	15.59
3	22.98	23.01	23.03	23.06	23.08	23.11	23.13	23.16	23.18	23.21	23.23	23.26	23.28	23.31	23.33	23.36	23.38
4	30.64	30.68	30.71	30.74	30.78	30.81	30.84	30.88	30.91	30.94	30.98	31.01	31.04	31.08	31.11	31.14	31.18
5	38.30	38.34	38.39	38.43	38.47	38.51	38.55	38.60	38.64	38.68	38.72	38.76	38.80	38.85	38.89	38.93	38.97
6	45.96	46.01	46.06	46.11	46.16	46.21	46.26	46.31	46.36	46.41	46.46	46.51	46.56	46.62	46.66	46.71	46.76
7	53.62	53.68	53.74	53.80	53.86	53.92	53.97	54.03	54.09	54.15	54.21	54.27	54.32	54.38	54.44	54.50	54.56
8	61.28	61.35	61.42	61.48	61.55	61.62	61.68	61.75	61.82	61.89	61.95	62.02	62.09	62.15	62.22	62.29	62.35
9	68.94	69.02	69.10	69.17	69.24	69.32	69.40	69.47	69.55	69.62	69.70	69.77	69.85	69.92	70.00	70.07	70.15
10	76.61	76.69	76.77	76.86	76.94	77.02	77.11	77.19	77.27	77.36	77.44	77.52	77.61	77.69	77.77	77.86	77.94
20	153.21	153.38	153.55	153.71	153.88	154.05	154.21	154.38	154.55	154.71	154.88	155.05	155.21	155.38	155.55	155.71	155.88
30	229.82	230.07	230.32	230.57	230.82	231.07	231.32	231.57	231.82	232.07	232.32	232.57	232.82	233.07	233.32	233.57	233.82
40	306.42	306.76	307.09	307.42	307.76	308.09	308.42	308.76	309.09	309.43	309.76	310.10	310.43	310.76	311.10	311.43	311.76
50	383.03	383.44	383.86	384.28	384.70	385.12	385.53	385.95	386.36	386.78	387.20	387.62	388.04	388.46	388.87	389.28	389.70
60	459.64	460.13	460.64	461.14	461.63	462.14	462.64	463.14	463.64	464.14	464.64	465.14	465.64	466.15	466.64	467.14	467.65
70	536.24	536.82	537.41	537.99	538.57	539.16	539.74	540.83	540.91	541.50	542.08	542.67	543.25	543.84	544.42	545.00	545.59
80	612.85	613.51	614.18	614.85	615.51	616.18	616.85	617.52	618.18	618.86	619.52	620.19	620.86	621.53	622.19	622.86	623.53
90	689.45	690.20	690.96	691.70	692.45	693.21	693.95	694.71	695.46	696.21	696.96	697.72	698.46	699.22	699.97	700.71	701.47
100	766.1	766.9	767.7	768.6	769.4	770.2	771.1	771.9	772.7	773.6	774.4	775.2	776.1	776.9	777.7	778.6	779.4
200	1532.1	1533.8	1535.5	1537.1	1538.8	1540.5	1542.1	1543.8	1545.5	1547.1	1548.8	1550.5	1552.1	1553.8	1555.5	1557.1	1558.8
300	2298.2	2300.7	2303.2	2305.7	2308.2	2310.7	2313.2	2315.7	2318.2	2320.7	2323.2	2325.7	2328.2	2330.7	2333.2	2335.7	2338.2
400	3064.2	3067.6	3070.9	3074.2	3077.6	3080.9	3084.2	3087.6	3090.9	3094.3	3097.6	3101.0	3104.3	3107.6	3111.0	3114.3	3117.6
500	3830.3	3834.4	3838.6	3842.8	3847.0	3851.2	3855.3	5859.5	3863.6	3867.8	3872.0	3876.2	3880.4	3884.6	3888.7	3892.8	3897.0
600	4596.4	4601.3	4606.4	4611.4	4616.3	4621.4	4626.4	4631.4	4636.4	4641.4	4646.4	4651.4	4656.4	4661.5	4666.4	4671.4	4676.5
700	5362.4	5368.2	5374.1	5379.9	5385.7	5391.6	5397.4	5403.3	5409.1	5415.0	5420.8	5426.7	5432.5	5438.4	5444.2	5450.0	5455.9
800	6128.5	6135.1	6141.8	6148.5	6155.1	6161.8	6168.5	6175.2	6181.8	6188.6	6195.2	6201.9	6208.6	6215.3	6221.9	6228.6	6235.3
900	6894.5	6902.0	6909.6	6917.0	6924.5	6932.1	6939.5	6947.1	6954.6	6962.1	6969.6	6977.2	6984.6	6992.2	6999.7	7007.1	7014.7
1000	7661	7669	7677	7686	7694	7702	7711	7719	7727	7736	7744	7752	7761	7769	7777	7786	7794
2000	15321	15338	15355	15371	15388	15405	15421	15438	15455	15471	15488	15505	15521	15538	15555	15571	15588
3000	22982	23007	23032	23057	23082	23107	23132	23157	23182	23207	23232	23257	23282	23307	23332	23357	28382
4000	30642	30676	30709	30742	30776	30809	30842	30876	30909	30943	30976	31010	31043	31076	31110	31143	31176
5000	38303	38344	38386	38428	38470	38512	38553	38595	38636	38678	38720	38762	38804	38846	38887	38928	38970
6000	45964	46013	46064	46114	46163	46214	46264	46314	46364	46414	46464	46514	46564	46615	46664	46714	46765
7000	53624	53682	53741	53799	53857	53916	53974	54033	54091	54150	54208	54267	54325	54384	54442	54500	54559
8000	61285	61351	61418	61485	61551	61618	61685	61752	61818	61886	61952	62019	62086	62153	62219	62286	62353
9000	68945	69020	69096	69170	69245	69321	69395	69471	69546	69621	69696	69772	69846	69922	69997	70071	70147
10000	76606	76689	76773	76856	76939	77023	77106	77190	77273	77357	77440	77524	77607	77691	77774	77857	77941

NOTE.—These tables are calculated on the assumption that the densities are measured at 20° and that the weighings are made at the same temperature in air of 50 per cent humidity, and at a pressure of 760 mm. of mercury against brass weights having a density of 8.4. The tables may be used, without appreciable error, for determinations at all temperatures between 10° and 40° and under all ordinary conditions of humidity and pressure.

TABLE III

Volumes (in Gallons) of Various Weights (in Pounds) of Linseed Oil

Pounds	Density of Oil (in grams per milliliter) 0.9190	0.9200	0.9210	0.9220	0.9230	0.9240	0.9250	0.9260	0.9270	0.9280	0.9290	0.9300	0.9310	0.9320	0.9330	0.9340	0.9350
	Gallons of Oil																
1	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
2	.26	.26	.26	.26	.26	.26	.26	.26	.26	.26	.26	.25	.25	.25	.25	.25	.25
3	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.39	.38
4	.52	.52	.52	.52	.52	.52	.52	.52	.52	.52	.52	.52	.52	.51	.51	.51	.51
5	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.65	.64	.64	.64	.64	.64	.64
6	.78	.78	.78	.78	.78	.78	.78	.78	.78	.78	.77	.77	.77	.77	.77	.77	.77
7	.91	.91	.91	.91	.91	.91	.91	.91	.91	.90	.90	.90	.90	.90	.90	.90	.90
8	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
9	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.15
10	1.31	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.29	1.29	1.29	1.29	1.29	1.29	1.29	1.28	1.28
20	2.61	2.61	2.60	2.60	2.60	2.60	2.59	2.59	2.59	2.59	2.58	2.58	2.58	2.57	2.57	2.57	2.57
30	3.92	3.91	3.91	3.90	3.90	3.89	3.89	3.89	3.88	3.88	3.87	3.87	3.87	3.86	3.86	3.85	3.85
40	5.22	5.22	5.21	5.20	5.20	5 19	5.19	5.18	5.18	5.17	5.17	5.16	5.15	5.15	5.14	5.14	5.13
50	6.53	6.52	6.51	6.51	6.50	6.49	6.48	6.48	6.47	6.46	6.46	6.45	6.44	6.44	6.43	6.42	6.42
60	7.83	7.82	7.82	7.81	7.80	7.79	7.78	7.77	7.76	7.76	7 75	7 74	7.73	7.72	7.71	7.71	7.70
70	9.14	9.13	9.12	9.11	9.10	9.09	9.08	9.07	9.06	9.05	9.04	9.03	9.02	9.01	9.00	8.99	8.98
80	10.44	10.43	10.42	10.41	10.40	10.39	10.38	10.36	10.35	10.34	10.33	10.32	10.31	10.30	10.29	10.28	10.26
90	11.75	11.74	11.72	11.71	11.70	11.68	11.67	11.66	11.65	11.63	11.62	11.61	11.60	11.58	11.57	11.56	11.55
100	13.05	13.04	13.02	13.01	13.00	12.98	12.97	12.96	12.94	12.93	12.91	12.90	12.88	12.87	12.86	12.84	12.83
200	26.11	26.08	26.05	26.02	25.99	25.97	25.94	25.91	25.88	25.85	25.83	25.80	25.77	25.74	25.72	25.69	25.66
300	39.16	39.12	39.08	39.03	38.99	38.95	38.91	38.86	38.82	38.78	38.74	38.70	38.66	38.62	38.57	38.53	38.49
400	52.21	52.16	52.10	52.04	51.99	51.93	51.88	51.82	51.76	51.71	51.65	51.60	51.54	51.49	51.43	51.38	51.32
500	65.26	65.20	65.12	65.06	64.98	64.92	64.84	64.78	64.70	64.64	64.56	64.50	64.42	64.36	64.29	64.22	64.15
600	78.32	78.24	78.15	78.07	77.98	77.90	77.81	77.73	77.65	77.56	77.48	77.39	77.31	77.23	77.15	77.06	76.98
700	91.37	91.28	91.18	91.08	90.98	90.88	90.78	90.68	90.59	90.49	90.39	90.29	90.20	90.10	90.01	89.91	89.81
800	104.42	104.32	104.20	104.09	103.98	103.86	103.75	103.64	103.53	103.42	103.30	103.19	103.08	102.98	102.86	102.75	102.64
900	117.48	117.36	117.22	117.10	116.97	116.85	116.72	116.60	116.47	116.34	116.22	116.09	115.96	115.85	115.72	115.60	115.47
1000	130.53	130.40	130.25	130.11	129.97	129.83	129.69	129.55	129.41	129.27	129.13	128.99	128.85	128.72	128.58	128.44	128.30
2000	261.06	260.80	260.50	260.22	259.94	259.66	259.38	259.10	258.82	258.54	258.26	257.98	257.70	257.44	257.16	256.88	256.60
3000	391.59	391.20	390.75	390.33	389.91	389.49	389.07	388.65	388.23	387.81	387.39	386.97	386.55	386.16	385.74	385.32	384.90
4000	522.12	521.60	521.00	520.44	519.88	519.32	518.76	518.20	517.64	517.08	516.52	515.96	515.40	514.88	514.32	513.76	513.20
5000	652.65	652.00	651.25	650.55	649.85	649.15	648.45	647.75	647.05	646.35	645.65	644.95	644.25	643.60	642.90	642.20	641.50
6000	783.18	782.40	781.50	780.66	779.82	778.98	778.14	777.30	776.46	775.62	774.78	773.94	773.10	772.32	771.48	770.64	769.80
7000	913.71	912.80	911.75	910.77	909.79	908.81	907.83	906.85	905.87	904.89	903.91	902.93	901.95	901.04	900.06	899.08	898.10
8000	1044.24	1043.20	1042.00	1040.88	1039.76	1038.64	1037.52	1036.40	1035.28	1034.16	1033.04	1031.92	1030.80	1029.76	1028.64	1027.52	1026.40
9000	1174.77	1173.60	1172.25	1170.99	1169.73	1168.47	1167.21	1165.95	1164.69	1163.43	1162.17	1160.91	1159.65	1158.48	1157.22	1155.96	1154.70
10 000	1305.3	1304.0	1302.5	1301.1	1299.7	1298.3	1296.9	1295.5	1294.1	1292.7	1291.3	1289.9	1288.5	1287.2	1285.8	1284.4	1283.0

TABLE IV

Density of Turpentine at Temperatures from 10° to 40° C from its Density at 20° C

Required temperature	Density at 20° C (in grams per milliliter)															
	0.8550	0.8560	0.8570	0.8580	0.8590	0.8600	0.8610	0.8620	0.8630	0.8640	0.8650	0.8660	0.8670	0.8680	0.8690	0.8700
	Density at required temperature															
°C																
10	0.8631	0.8641	0.8651	0.8661	0.8671	0.8681	0.8691	0.8701	0.8711	0.8722	0.8732	0.8742	0.8752	0.8762	0.8772	0.8782
11	.8623	.8633	.8643	.8653	.8663	.8673	.8683	.8693	.8703	.8713	.8724	.8734	.8744	.8754	.8764	.8774
12	.8614	.8625	.8635	.8645	.8655	.8665	.8675	.8685	.8695	.8705	.8715	.8725	.8735	.8746	.8756	.8766
13	.8606	.8616	.8627	.8637	.8647	.8657	.8667	.8677	.8687	.8697	.8707	.8717	.8727	.8737	.8747	.8758
14	.8598	.8608	.8618	.8629	.8639	.8649	.8659	.8669	.8679	.8689	.8699	.8709	.8719	.8729	.8739	.8749
15	.8590	.8600	.8610	.8620	.8630	.8641	.8651	.8661	.8671	.8681	.8691	.8701	.8711	.8721	.8731	.8741
16	.8582	.8592	.8602	.8612	.8622	.8632	.8642	.8652	.8663	.8673	.8683	.8693	.8703	.8713	.8723	.8733
17	.8574	.8584	.8594	.8604	.8614	.8624	.8634	.8644	.8654	.8664	.8674	.8684	.8695	.8705	.8715	.8725
18	.8566	.8576	.8586	.8596	.8606	.8616	.8626	.8636	.8646	.8656	.8666	.8676	.8686	.8696	.8706	.8716
19	.8558	.8568	.8578	.8588	.8598	.8608	.8618	.8628	.8638	.8648	.8658	.8668	.8678	.8688	.8698	.8708
20	.8550	.8560	.8570	.8580	.8590	.8600	.8610	.8620	.8630	.8640	.8650	.8660	.8670	.8680	.8690	.8700
21	.8542	.8552	.8562	.8572	.8582	.8592	.8602	.8612	.8622	.8632	.8642	.8652	.8662	.8672	.8682	.8692
22	.8534	.8544	.8554	.8564	.8674	.8584	.8594	.8604	.8614	.8624	.8634	.8644	.8654	.8664	.8674	.8684
23	.8526	.8536	.8546	.8556	.8566	.8576	.8586	.8596	.8606	.8616	.8626	.8636	.8645	.8655	.8665	.8675
24	.8518	.8528	.8538	.8548	.8558	.8568	.8578	.8587	.8597	.8607	.8617	.8627	.8637	.8647	.8657	.8667
25	.8510	.8520	.8530	.8540	.8549	.8559	.8569	.8579	.8589	.8599	.8609	.8619	.8629	.8639	.8649	.8659
26	.8502	.8512	.8521	.8531	.8541	.8551	.8561	.8571	.8581	.8591	.8601	.8611	.8621	.8631	.8641	.8651
27	.8493	.8503	.8513	.8523	.8533	.8543	.8553	.8563	.8573	.8583	.8593	.8603	.8613	.8623	.8632	.8642
28	.8485	.8495	.8505	.8515	.8525	.8535	.8545	.8555	.8565	.8575	.8585	.8594	.8604	.8614	.8624	.8634
29	.8477	.8487	.8497	.8507	.8517	.8527	.8537	.8547	.8557	.8566	.8576	.8586	.8596	.8606	.8616	.8626
30	.8469	.8479	.8489	.8499	.8509	.8519	.8529	.8538	.8548	.8558	.8568	.8578	.8588	.8598	.8608	.8618
31	.8461	.8471	.8481	.8491	.8501	.8510	.8520	.8530	.8540	.8550	.8560	.8570	.8580	.8590	.8600	.8610
32	.8453	.8463	.8473	.8483	.8492	.8502	.8512	.8522	.8532	.8542	.8552	.8562	.8572	.8582	.8591	.8601
33	.8445	.8455	.8465	.8474	.8484	.8494	.8504	.8514	.8524	.8534	.8544	.8554	.8563	.8573	.8583	.8593
34	.8437	.8447	.8456	.8466	.8476	.8486	.8496	.8506	.8516	.8526	.8535	.8545	.8555	.8565	.8575	.8585
35	.8429	.8438	.8448	.8458	.8468	.8478	.8488	.8498	.8508	.8517	.8527	.8537	.8547	.8557	.8567	.8576
36	.8421	.8430	.8440	.8450	.8460	.8470	.8480	.8490	.8499	.8509	.8519	.8529	.8539	.8549	.8558	.8568
37	.8412	.8422	.8432	.8442	.8452	.8462	.8472	.8481	.8491	.8501	.8511	.8521	.8530	.8540	.8550	.8560
38	.8404	.8414	.8424	.8434	.8444	.8454	.8463	.8473	.8483	.8493	.8503	.8512	.8522	.8532	.8542	.8552
39	.8396	.8406	.8416	.8426	.8435	.8445	.8455	.8465	.8475	.8485	.8494	.8504	.8514	.8524	.8534	.8544
40	.8388	.8398	.8408	.8418	.8427	.8437	.8447	.8457	.8467	.8476	.8486	.8496	.8506	8516	.8526	.8535

TABLE V

Weights (in Pounds) of Various Volumes (in Gallons) of Turpentine

	Density of Turpentine (in grams per milliliter)													
	0.8470	0.8480	0.8490	0.8500	0.8510	0.8520	0.8530	0.8540	0.8550	0.8560	0.8570	0.8580	0.8590	0.8600
Gallons	Weight of Turpentine (in pounds)													
1	7.06	7.07	7.08	7.08	7.09	7.10	7.11	7.12	7.13	7.13	7.14	7.15	7.16	7.17
2	14.12	14.14	14.15	14 17	14.19	14.20	14.22	14.24	14.25	14.27	14.29	14.30	14.32	14.34
3	21.18	21.20	21.23	21.25	21.28	21.30	21.33	21.35	21.38	21.40	21.43	21.45	21.48	21.50
4	28.24	28.27	28.31	28.34	28.37	28.41	28.44	28.47	28.51	28.54	28.57	28.61	28.64	28.67
5	35.30	35.34	35.38	35.42	35.47	35.51	35.55	35.59	35.63	35.67	35.72	35.76	35.80	35.84
6	42.36	42.41	42.46	42.51	42.56	42.61	42.66	42.71	42.76	42.81	42.86	42.91	42.96	43.01
7	49.42	49.48	49.53	49.59	49.65	49.71	49.77	49.83	49.89	49.94	50.00	50.06	50.12	50.18
8	56.48	56.54	56.61	56.68	56.74	56.81	56.88	56.94	57.01	57.08	57.14	57.21	57.28	57.35
9	63.54	63.61	63.69	63.76	63.84	63.91	63.99	64.06	64.14	64.21	64.29	64.36	64.44	64.51
10	70.60	70.68	70.76	70.85	70.93	71.01	71.10	71.18	71.26	71.35	71.43	71.52	71.60	71.68
20	141.19	141.36	141.53	141.69	141.86	142.03	142.20	142.36	142.53	142.70	142.86	143.03	143.20	143.36
30	211.79	212.04	212.29	212.54	212.79	213.04	213.29	213.54	213.80	214.04	214.29	214.54	214.79	215.05
40	282.39	282.72	283.06	283.39	283.72	284.06	284.39	284.72	285.06	285.39	285.72	286.06	286.39	286.73
50	352.98	353.40	353.82	354.24	354.66	355.07	355.49	355.90	356.32	356.74	357.16	357.58	357.99	358.41
60	423.58	424.08	424.58	425.08	425.59	426.08	426.59	427.09	427.59	428.09	428.59	429.09	429.59	430.09
70	494.18	494.76	495.35	495.93	496.52	497.10	497.69	498.27	498.86	499.44	500.02	500.60	501.19	501.77
80	564.78	565.44	566.11	566.78	567.45	568.11	568.78	569.45	570.12	570.78	571.45	572.12	572.78	573.46
90	635.37	636.12	636.88	637.63	638.38	639.13	639.88	640.63	641.38	642.13	642.88	643.64	644.38	645.14
100	706.0	706.8	707.6	708.5	709.3	710.1	711.0	711.8	712.6	713.5	714.3	715.2	716.0	716.8
200	1411.9	1413.6	1415.3	1416.9	1418.6	1420.3	1422.0	1423.6	1425.3	1427.0	1428.6	1430.3	1432.0	1433.6
300	2117.9	2120.4	2122.9	2125.4	2127.9	2130.4	2132.9	2135.4	2138.0	2140.4	2142.9	2145.4	2147.9	2150.5
400	2823.9	2827.2	2830.6	2833.9	2837.2	2840.6	2843.9	2847.2	2850.6	2853.9	2857.2	2860.6	2863.9	2867.3
500	3529.8	3534.0	3538.2	3542.4	3546.6	3550.7	3554.9	3559.0	3563.2	3567.4	3571.6	3575.8	3579.9	3584.1
600	4235.8	4240.8	4245.8	4250.8	4255.9	4260.8	4265.9	4270.9	4275.9	4280.9	4285.9	4290.9	4295.9	4300.9
700	4941.8	4947.6	4953.5	4959.3	4965.2	4971.0	4976.9	4982.7	4988.6	4994.4	5000.2	5006.0	5011.9	5017.7
800	5647.8	5654.4	5661.1	5667.8	5674.5	5681.1	5687.8	5694.5	5701.2	5707.8	5714.5	5721.2	5727.8	5734.6
900	6353.7	6361.2	6368.8	6376.3	6383.8	6391.3	6398.8	6406.3	6413.8	6421.3	6428.8	6436.4	6443.8	6451.4
1000	7060	7068	7076	7085	7093	7101	7110	7118	7126	7135	7143	7152	7160	7168
2000	14119	14136	14153	14169	14186	14203	14220	14236	14253	14270	14286	14303	14320	14336
3000	21179	21204	21229	21254	21279	21304	21329	21354	21380	21404	21429	21454	21479	21505
4000	28239	28272	28306	28339	28372	28406	28439	28472	28506	28539	28572	28606	28639	28673
5000	35298	35340	35382	35424	35466	35507	35549	35590	35632	35674	35716	35758	35799	35841
6000	42358	42408	42458	42508	42559	42608	42659	42709	42759	42809	42859	42909	42959	43009
7000	49418	49476	49535	49593	49652	49710	49769	49827	49886	49944	50002	50060	50119	50177
8000	56478	56544	56611	56678	56745	56811	56878	56945	57012	57078	57145	57212	57278	57346
9000	63537	63612	63688	63763	63838	63913	63988	64063	64138	64213	64288	64364	64438	64514
10000	70597	70680	70764	70847	70931	71014	71098	71181	71265	71348	71431	71515	71598	71682

Gallons	Density of Turpentine (in grams per milliliter) 0.8610	0.8620	0.8630	0.8640	0.8650	0.8660	0.8670	0.8680	0.8690	0.8700	0.8710	0.8720	0.8730	0.8740
	Weight of Turpentine (in pounds)													
1	7.18	7.18	7.19	7.20	7.21	7.22	7.23	7.24	7.24	7.25	7.26	7.27	7.28	7.28
2	14.35	14.37	14.39	14.40	14.42	14.44	14.45	14.47	14.49	14.50	14.52	14.54	14.55	14.57
3	21.53	21.56	21.58	21.60	21.63	21.66	21.68	21.70	21.73	21.76	21.78	21.80	21.83	21.86
4	28.71	28.74	28.77	28.81	28.84	28.87	28.91	28.94	28.97	29.01	29.04	29.07	29.11	29.14
5	35.88	35.92	35.97	36.01	36.05	36.09	36.13	36.17	36.22	36.26	36.30	36.34	36.38	36.42
6	43.06	43.11	43.16	43.21	43.26	43.31	43.36	43.41	43.46	43.51	43.56	43.61	43.66	43.71
7	50.24	50.29	50.35	50.41	50.47	50.53	50.59	50.64	50.70	50.76	50.82	50.87	50.94	51.00
8	57.41	57.48	57.55	57.61	57.68	57.75	57.81	57.88	57.95	58.01	58.08	58.15	58.21	58.28
9	64.59	64.66	64.74	64.81	64.89	64.97	65.04	65.11	65.19	65.26	65.34	65.41	65.49	65.56
10	71.76	71.85	71.93	72.02	72.10	72.18	72.27	72.35	72.43	72.52	72.60	72.68	72.77	72.85
20	143.53	143.70	143.86	144.03	144.20	144.37	144.53	144.70	144.87	145.03	145.20	145.37	145.53	145.70
30	215.30	215.55	215.80	216.05	216.30	216.55	216.80	217.05	217.30	217.55	217.80	218.05	218.30	218.55
40	287.06	287.40	287.73	288.06	288.40	288.73	289.06	289.40	289.73	290.06	290.40	290.73	291.07	291.40
50	358.82	359.24	359.66	360.08	360.50	360.92	361.33	361.74	362.16	362.58	363.00	363.42	363.84	364.25
60	430.59	431.09	431.59	432.10	432.59	433.10	433.60	434.09	434.60	435.10	435.60	436.10	436.60	437.10
70	502.36	502.94	503.52	504.11	504.69	505.28	505.86	506.44	507.03	507.61	508.20	508.78	509.37	509.95
80	574.12	574.79	575.46	576.13	576.79	577.46	578.13	578.79	579.46	580.13	580.80	581.46	582.14	582.80
90	645.88	646.64	647.39	648.14	648.89	649.65	650.39	651.14	651.90	652.64	653.40	654.15	654.90	655.65
100	717.6	718.5	719.3	720.2	721.0	721.8	722.7	723.5	724.3	725.2	726.0	726.8	727.7	728.5
200	1435.3	1437.0	1438.6	1440.3	1442.0	1443.7	1445.3	1447.0	1448.7	1450.3	1452.0	1453.7	1455.3	1457.0
300	2153.0	2155.5	2158.0	2160.5	2163.0	2165.5	2168.0	2170.5	2173.0	2175.5	2178.0	2180.5	2183.0	2185.5
400	2870.6	2874.0	2877.3	2880.6	2884.0	2887.3	2890.6	2894.0	2897.3	2900.6	2904.0	2907.3	2910.7	2914.0
500	3588.2	3592.4	3596.6	3600.8	3605.0	3609.2	3613.3	3617.4	3621.6	3625.8	3630.0	3634.2	3638.4	3642.5
600	4305.9	4310.4	4315.9	4321.0	4325.9	4331.0	4336.0	4340.9	4346.0	4351.0	4356.0	3361.0	4366.0	4371.0
700	5023.6	5029.4	5035.2	5041.1	5046.9	5052.8	5058.6	5064.4	5070.3	5076.1	5082.0	5087.8	5093.7	5099.5
800	5741.2	5747.9	5754.6	5761.3	5767.9	5774.6	5781.3	5787.9	5794.6	5801.3	5808.0	5814.6	5821.4	5828.0
900	6458.8	6466.4	6473.9	6481.4	6488.9	6496.5	6503.9	6511.4	6519.0	6526.4	6534.0	6541.5	6549.0	6556.5
1000	7176	7185	7193	7202	7210	7218	7227	7235	7243	7252	7260	7268	7277	7285
2000	14353	14370	14386	14403	14420	14437	14453	14470	14487	14503	14520	14537	14553	14570
3000	21530	21555	21580	21605	21630	21655	21680	21705	21730	21755	21780	21805	21830	21855
4000	28706	28740	28773	28806	28840	28873	28906	28940	28973	29006	29040	29073	29107	29140
5000	35882	35924	35966	36008	36050	36092	36133	36174	36216	36258	36300	36342	36384	36425
6000	43059	43109	43159	43210	43259	43310	43360	43409	43460	43510	43560	43610	43660	43710
7000	50236	50294	50352	50411	50469	50528	50586	50644	50703	50761	50820	50878	50937	50995
8000	57412	57479	57546	57613	57679	57746	57813	57879	57946	58013	58080	58146	58214	58280
9000	64588	64664	64739	64814	64889	64965	65039	65114	65190	65264	65340	65415	65490	65565
10000	71765	71849	71932	72016	72099	72183	72266	72349	72433	72516	72600	72683	72767	72850

TABLE VI

Volumes (in Gallons) of Various Weights (in Pounds) of Turpentine

Pounds	Density of Turpentine (in grams per milliliter)													
	0.8470	0.8480	0.8490	0.8500	0.8510	0.8520	0.8530	0.8540	0.8550	0.8560	0.8570	0.8580	0.8590	0.8600
	Gallons of Turpentine													
1	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
2	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28
3	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42	.42
4	.57	.57	.57	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56	.56
5	.71	.71	.71	.71	.70	.70	.70	.70	.70	.70	.70	.70	.70	.70
6	.85	.85	.85	.85	.85	.84	.84	.84	.84	.84	.84	.84	.84	.84
7	.99	.99	.99	.99	.99	.99	.98	.98	.98	.98	.98	.98	.98	.98
8	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.12	1.12	1.12	1.12	1.12	1.12	1.12
9	1.27	1.27	1.27	1.27	1.27	1.27	1.27	1.26	1.26	1.26	1.26	1.26	1.26	1.26
10	1.42	1.41	1.41	1.41	1.41	1.41	1.41	1.40	1.40	1.40	1.40	1.40	1.40	1.40
20	2.83	2.83	2.83	2.82	2.82	2.82	2.81	2.81	2.81	2.80	2.80	2.80	2.79	2.79
30	4.25	4.24	4.24	4.23	4.23	4.22	4.22	4.21	4.21	4.20	4.20	4.19	4.19	4.19
40	5.67	5.66	5.65	5.65	5.64	5.63	5.63	5.62	5.61	5.61	5.60	5.59	5.59	5.58
50	7.08	7.07	7.07	7.06	7.05	7.04	7.03	7.02	7.02	7.01	7.00	6.99	6.98	6.98
60	8.50	8.49	8.48	8.47	8.46	8.45	8.44	8.43	8.42	8.41	8.40	8.39	8.38	8.37
70	9.92	9.90	9.89	9.88	9.87	9.86	9.85	9.83	9.82	9.81	9.80	9.79	9.78	9.77
80	11.33	11.32	11.31	11.29	11.28	11.27	11.25	11.24	11.23	11.21	11.20	11.19	11.17	11.16
90	12.75	12.73	12.72	12.70	12.69	12.67	12.66	12.64	12.63	12.61	12.60	12.58	12.57	12.56
100	14.16	14.15	14.13	14.12	14.10	14.08	14.07	14.05	14.03	14.02	14.00	13.98	13.97	13.95
200	28.33	28.30	28.26	28.23	28.20	28.16	28.13	28.10	28.06	28.03	28.00	27.97	27.93	27.90
300	42.49	42.44	42.39	42.34	42.29	42.25	42.20	42.15	42.10	42.05	42.00	41.95	41.90	41.85
400	56.66	56.59	56.53	56.46	56.39	56.33	56.26	56.20	56.13	56.06	56.00	55.93	55.87	55.80
500	70.82	70.74	70.66	70.58	70.49	70.41	70.33	70.24	70.16	70.08	70.00	69.92	69.84	69.76
600	84.99	84.89	84.79	84.69	84.59	84.49	84.40	84.29	84.19	84.10	84.00	83.90	83.80	83.71
700	99.15	99.04	98.92	98.80	98.69	98.57	98.46	98.34	98.22	98.11	98.00	97.88	97.77	97.66
800	113.32	113.19	113.05	112.92	112.78	112.66	112.53	112.39	112.26	112.13	112.00	111.86	111.74	111.61
900	127.48	127.33	127.18	127.04	126.88	126.74	126.59	126.44	126.29	126.14	126.00	125.85	125.70	125.56
1000	141.65	141.48	141.32	141.15	140.98	140.82	140.66	140.49	140.32	140.16	140.00	139.83	139.67	139.51
2000	283.30	282.97	282.63	282.30	281.96	281.64	281.32	280.98	280.64	280.32	280.00	279.66	279.34	279.02
3000	424.95	424.45	423.94	423.45	422.94	422.46	421.98	421.47	420.96	420.48	420.00	419.49	419.01	418.53
4000	566.60	565.93	565.26	564.60	563.92	563.28	562.64	561.96	561.28	560.64	560.00	559.32	558.68	558.04
5000	708.24	707.42	706.58	705.75	704.90	704.10	703.30	702.45	701.60	700.80	700.00	699.15	698.35	697.55
6000	849.89	848.90	847.89	846.90	845.88	844.92	843.96	842.94	841.92	840.96	840.00	838.98	838.02	837.06
7000	991.54	990.38	989.20	988.05	986.86	985.74	984.62	983.43	982.24	981.12	980.00	978.81	977.69	976.57
8000	1133.19	1131.86	1130.52	1129.20	1127.84	1126.56	1125.28	1123.92	1122.56	1121.28	1120.00	1118.64	1117.36	1116.08
9000	1274.84	1273.35	1271.84	1270.35	1268.82	1267.38	1265.94	1264.41	1262.88	1261.44	1260.00	1258.47	1257.03	1255.59
10000	1416.5	1414.8	1413.2	1411.5	1409.8	1408.2	1406.6	1404.9	1403.2	1401.6	1400.0	1398.3	1396.7	1395.1

	Density of Turpentine (in grams per milliliter)													
	0.8610	0.8620	0.8630	0.8640	0.8650	0.8660	0.8670	0.8680	0.8690	0.8700	0.8710	0.8720	0.8730	0.8740
Pounds	Gallons of Turpentine													
1	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
2	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.28	.27	.27
3	.42	.42	.42	.42	.42	.42	.42	.41	.41	.41	.41	.41	.41	.41
4	.56	.56	.56	.56	.55	.55	.55	.55	.55	.55	.55	.55	.55	.55
5	.70	.70	.70	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69	.69
6	.84	.84	.83	.83	.83	.83	.83	.83	.83	.83	.83	.83	.82	.82
7	.98	.97	.97	.97	.97	.97	.97	.97	.97	.97	.96	.96	.96	.96
8	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.11	1.10	1.10	1.10	1.10	1.10	1.10
9	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.24	1.24	1.24	1.24	1.24	1.24	1.24
10	1.39	1.39	1.39	1.39	1.39	1.39	1.38	1.38	1.38	1.38	1.38	1.38	1.37	1.37
20	2.79	2.78	2.78	2.78	2.77	2.77	2.77	2.76	2.76	2.76	2.76	2.75	2.75	2.75
30	4.18	4.18	4.17	4.17	4.16	4.16	4.15	4.15	4.14	4.14	4.13	4.13	4.12	4.12
40	5.57	5.57	5.56	5.55	5.55	5.54	5.54	5.53	5.52	5.52	5.51	5.50	5.50	5.49
50	6.97	6.96	6.95	6.94	6.94	6.93	6.92	6.91	6.90	6.90	6.89	6.88	6.87	6.86
60	8.36	8.35	8.34	8.33	8.32	8.31	8.30	8.29	8.28	8.27	8.26	8.25	8.24	8.24
70	9.75	9.74	9.73	9.72	9.71	9.70	9.69	9.67	9.66	9.65	9.64	9.63	9.62	9.61
80	11.15	11.13	11.12	11.11	11.10	11.08	11.07	11.06	11.04	11.03	11.02	11.01	10.99	10.98
90	12.54	12.53	12.51	12.50	12.48	12.47	12.45	12.44	12.42	12.41	12.40	12.38	12.37	12.35
100	13.93	13.92	13.90	13.89	13.87	13.85	13.84	13.82	13.81	13.79	13.77	13.76	13.74	13.73
200	27.87	27.84	27.80	27.77	27.74	27.71	27.68	27.64	27.61	27.58	27.55	27.52	27.48	27.45
300	41.80	41.75	41.71	41.66	41.61	41.56	41.51	41.47	41.42	41.37	41.32	41.27	41.23	41.18
400	55.74	55.67	55.61	55.54	55.48	55.42	55.35	55.29	55.22	55.16	55.10	55.03	54.97	54.91
500	69.67	69.59	69.51	69.43	69.35	69.27	69.19	69.11	69.03	68.95	68.87	68.79	68.71	68.63
600	83.60	83.51	83.41	83.32	83.22	83.12	83.03	82.93	82.84	82.74	82.64	82.55	82.45	82.36
700	97.54	97.43	97.31	97.20	97.09	96.98	96.87	96.75	96.64	96.53	96.42	96.31	96.19	96.09
800	111.47	111.34	111.22	111.09	110.96	110.83	110.70	110.58	110.45	110.32	110.19	110.06	109.94	109.81
900	125.41	125.26	125.12	124.97	124.83	124.69	124.54	124.40	124.25	124.11	123.97	123.82	123.68	123.54
1000	139.34	139.18	139.02	138.86	138.70	138.54	138.38	138.22	138.06	137.90	137.74	137.58	137.42	137.27
2000	278.68	278.36	278.04	277.72	277.40	277.08	276.76	276.44	276.12	275.80	275.48	275.16	274.84	274.54
3000	418.02	417.54	417.06	416.58	416.10	415.62	415.14	414.66	414.18	413.70	413.22	412.74	412.26	411.80
4000	557.36	556.72	556.08	555.44	554.80	554.16	553.52	552.88	552.24	551.60	550.96	550.32	549.68	549.07
5000	696.70	695.90	695.10	694.30	693.50	692.70	691.90	691.10	690.30	689.50	688.70	687.90	687.10	686.34
6000	836.04	835.08	834.12	833.16	832.20	831.24	830.28	829.32	828.36	827.40	826.44	825.48	824.52	823.61
7000	975.38	974.26	973.14	972.02	970.90	969.78	968.66	967.54	966.42	965.30	964.18	963.06	961.94	960.88
8000	1114.72	1113.44	1112.16	1110.88	1109.60	1108.32	1107.04	1105.76	1104.48	1103.20	1101.92	1100.64	1099.36	1098.14
9000	1254.06	1252.62	1251.18	1249.74	1248.30	1246.86	1245.42	1243.98	1242.54	1241.10	1239.66	1238.22	1236.78	1235.41
10000	1393.4	1391.8	1390.2	1388.6	1387.0	1385.4	1383.8	1382.2	1380.6	1379.0	1377.4	1375.8	1374.2	1372.7